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SOLAR/1002-78/12

Monthly Performance Report

WASHINGTON NATURAL GAS

DECEMBER 1978

FEB 25 1980

U.S. Department of Energy

National Solar Heating and Cooling Demonstration Program

National Solar Data Program

4295

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MONTHLY PERFORMANCE REPORT

WASHINGTON NATURAL GAS COMPANY

DECEMBER 1978

I. SYSTEM DESCRIPTION

The Washington Natural Gas Company site is a single-family residence in Kirkland, Washington. The home has approximately 2607 square feet of conditioned space. Solar energy is used for space heating the home and preheating domestic hot water (DHW). The solar energy system has an array of flat-plate collectors with a gross area of 591 square feet. The array faces south at an angle of 57 degrees to the horizontal. Air is the transfer medium that delivers solar energy from the collector array to storage and to the space heating and hot water loads. Solar energy is stored underground in a 273-cubic-foot bin containing 27,300 pounds of smooth stones. The bin has two inches of styrofoam insulation. Preheated city water is stored in an 80-gallon preheat storage tank and supplied, on demand, to a conventional 50-gallon DHW tank. When solar energy is insufficient to satisfy the space heating load, a gas furnace provides auxiliary energy for space heating. Similarly, a gas-fired unit in the DHW tank provides auxiliary energy for water heating. The system, shown schematically in Figure 1, has four modes of solar operation.

Mode 1 - Collector-to-Storage: This mode activates when there is no demand for space heating, and the temperature of the collector outlet exceeds that of the solar energy storage bin as measured by the control system sensors. Air circulates from the collector, through the air-to-liquid heat exchanger, through the air-handling unit and then through the solar energy storage bin to the collector. This mode exists as long as the temperature of the storage bin does not exceed 140°F.

Mode 2 - Storage-to-Space Heating: This mode activates when space heating is required, the solar insolation is insufficient to furnish the required energy from the collector, and the temperature of the solar energy storage bin is higher than 90°F, as indicated by the control system sensors. Air circulates from the solar energy storage bin, through the air-handling unit and gas furnace, then returns to the storage bin, bypassing the collectors.

Mode 3 - Collector-to-DHW Tank: This mode activates during the summer when the collector outlet temperature is higher than the temperature of the water in the preheat tank as indicated by the control system sensors. Air circulates from the collector, through the air-to-liquid heat exchanger and the air-handling unit, and returns to the collectors, bypassing the solar energy storage bin. Domestic water preheating also occurs in modes 1 and 4.

Mode 4 - Collector-to-Space Heating: This mode activates when the collector is operating, and the plenum temperature at the top of storage as indicated by the control system sensors is higher than the minimum value suitable for supplying heat to the house. Heated air is circulated through the house by the air-handling unit before being returned to the collector.

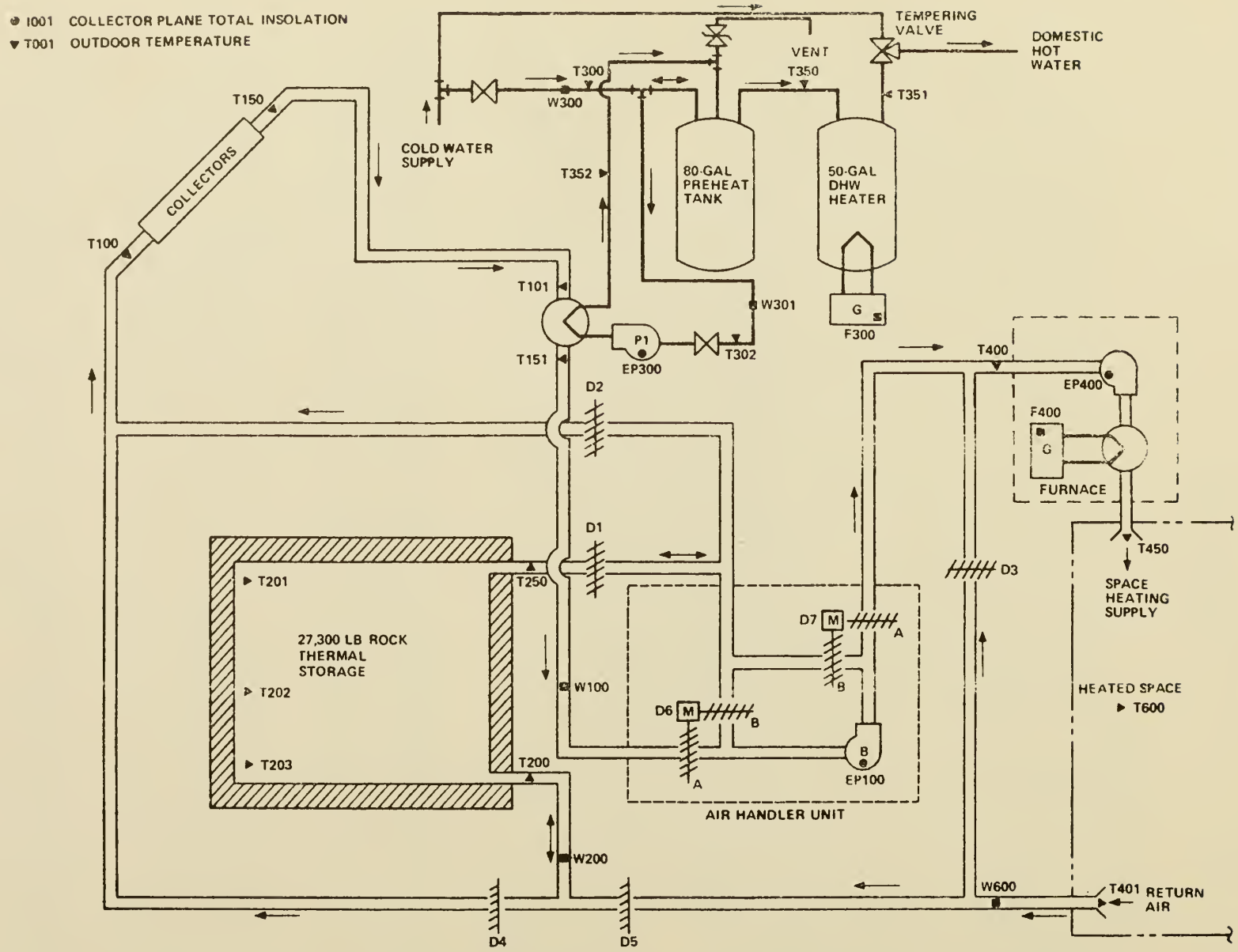

Figure 1. WASHINGTON NATURAL GAS SOLAR ENERGY SYSTEM SCHEMATIC

II. PERFORMANCE EVALUATION

INTRODUCTION

During the month of December the grantee replaced the fuel flow switches for the DHW heater and the gas-fired furnace with gas flowmeters. This should greatly increase the accuracy of determining the amount of gas consumed. The grantee also worked on the system seeking out air leaks and sealing any that were detected and accessible.

WEATHER CONDITIONS

During the month, total incident solar energy on the collector array was 9.6 million Btu for a daily average of 522 Btu per square foot. This was above the estimated average daily solar radiation for this geographical area during December of 466 Btu per square foot for a south-facing plane with a tilt of 57 degrees to the horizontal. The average ambient temperature during December was 38°F as compared with the long-term average for December of 41°F.

THERMAL PERFORMANCE

Collector - The total incident solar radiation on the collector array for the month of December was 9.6 million Btu. During the period the collector loop was operating, the total insolation amounted to 6.0 million Btu. The total collected solar energy for the month of December was 1.9 million Btu, resulting in a collector array efficiency of 19 percent, based on total incident insolation. Solar energy delivered from the collector array to storage was 1.1 million Btu. Operational energy required by the collector loop was 0.62 million Btu.

Storage - Solar energy delivered to storage was 1.1 million Btu. There were 0.10 million Btu delivered from storage to the space heating subsystem. The storage efficiency was 8 percent: This is calculated as the ratio of the sum of the energy removed from storage and the change in stored energy, to the energy delivered to storage. The average storage temperature for the month was 70°F.

DHW Load - The DHW subsystem consumed 0.30 million Btu of solar energy and 2.0 million Btu of auxiliary fossil fuel energy to satisfy a hot water load of 1.5 million Btu. The solar fraction of this load was 20 percent. Losses from the DHW subsystem were 0.81 million Btu. The DHW subsystem consumed a total of 0.017 million Btu of operational energy, resulting in an electrical energy expense of 0.017 million Btu. A daily average of 56 gallons of DHW was consumed at an average temperature of 153°F delivered from the tank.

Space Heating Load - The space heating subsystem consumed 0.14 million Btu of solar energy and 5.04 million Btu of auxiliary fossil fuel energy to satisfy a space heating load of 3.2 million Btu. The solar fraction of this load was 5 percent. Losses from the space heating subsystem were 2.0 million Btu. The

space heating subsystem consumed a total of 0.52 million Btu of operating energy, resulting in a fossil fuel energy savings of 0.24 million Btu.

OBSERVATIONS

There still remains some differences between the air-flow measurements of sensors W100 and W200. Sensor W200 must measure the air flow in two directions; therefore, the placement of that sensor in the duct is very critical. Normally an air-flow sensor is located in the duct where the average air flow occurs but the location of the point of average flow for air entering storage is not the same as for air leaving storage. Therefore, a compromise in the placement of W200 in the duct must be made and compensation for the difference between the air-flow sensor reading and the actual flow must be made in the software based on the direction of air flow. This is one reason why Boeing has been doing so much air mapping at this site.

ENERGY SAVINGS

The solar energy system provided a total fossil fuel energy savings of 0.81 million Btu. The DHW subsystem provided a fossil fuel energy savings of 0.51 million Btu. The space heating subsystem contributed a fossil fuel energy savings of 0.24 million Btu. The difference between the total fossil fuel energy savings and the sum of the DHW fossil fuel energy saving, plus the space heating fossil fuel energy savings is due to the bridging technique used in each calculation.

III. ACTION STATUS

Boeing is planning to perform another air-mapping survey on this solar energy system in the near future.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: WASHINGTON NATURAL GAS
REPORT PERIOD: DECEMBER,1978

SOLAR/1002-78/12

SITE/SYSTEM DESCRIPTION:
THE WASHINGTON NATURAL GAS SOLAR HEATING SYSTEM PROVIDES SPACE HEATING AND HOT WATER. AUXILIARY ENERGY IS SUPPLIED BY A FURNANCE FOR SPACE HEATING AND BY A GAS WATER HEATER FOR HOT WATER.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	9.568 MILLION BTU
	16190 BTU/SQ.FT.
COLLECTED SOLAR ENERGY	1.847 MILLION BTU
	3126 BTU/SQ.FT.
AVERAGE AMBIENT TEMPERATURE	38 DEGREES F
AVERAGE BUILDING TEMPERATURE	70 DEGREES F
ECSS SOLAR CONVERSION EFFICIENCY	0.05
ECSS OPERATING ENERGY	0.622 MILLION BTU
TOTAL SYSTEM OPERATING ENERGY	0.539 MILLION BTU
TOTAL ENERGY CONSUMED	9.286 MILLION BTU

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	1.530	3.164	N.A.	4.612 MILLION BTU
SOLAR FRACTION	20	5	N.A.	11 PERCENT
SOLAR ENERGY USED	0.304	0.142	N.A.	0.489 MILLION BTU
OPERATING ENERGY	0.017	0.522	N.A.	0.539 MILLION BTU
AUX. THERMAL ENERGY	1.226	3.021	N.A.	4.123 MILLION BTU
AUX. ELECTRIC FUEL	N.A.	N.A.	N.A.	N.A. MILLION BTU
AUX. FOSSIL FUEL	2.043	5.036	N.A.	6.872 MILLION BTU
ELECTRICAL SAVINGS	-0.017	0.000	N.A.	-0.639 MILLION BTU
FOSSIL SAVINGS	0.507	0.237	N.A.	0.814 MILLION BTU

SYSTEM PERFORMANCE FACTOR: 0.532

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978, SOLAR/0004-78/18

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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: WASHINGTON NATURAL GAS
REPORT PERIOD: DECEMBER,1978

SOLAR/1002-78/12

SITE/SYSTEM DESCRIPTION:
THE WASHINGTON NATURAL GAS SOLAR HEATING SYSTEM PROVIDES SPACE HEATING AND HOT WATER. AUXILIARY ENERGY IS SUPPLIED BY A FURNANCE FOR SPACE HEATING AND BY A GAS WATER HEATER FOR HOT WATER.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	10.094	GIGA JOULES
	183848	KJ/SQ.M.
COLLECTED SOLAR ENERGY	1.949	GIGA JOULES
	35498	KJ/SQ.M.
AVERAGE AMBIENT TEMPERATURE	3	DEGREES C
AVERAGE BUILDING TEMPERATURE	21	DEGREES C
ECSS SOLAR CONVERSION EFFICIENCY	0.05	
FCSS OPERATING ENERGY	0.656	GIGA JOULES
TOTAL SYSTEM OPERATING ENERGY	0.568	GIGA JOULES
TCTAL ENERGY CONSUMED	9.796	GIGA JOULES

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LCAD	1.615	3.338	N.A.	4.866 GIGA JOULES
SCLAR FRACTION	20	5	N.A.	11 PERCENT
SCLAR ENERGY USED	0.321	0.150	N.A.	0.515 GIGA JOULES
OPERATING ENERGY	0.018	0.550	N.A.	0.568 GIGA JOULES
AUX. THERMAL ENG	1.294	3.188	N.A.	4.350 GIGA JOULES
AUX. ELECTRIC FUEL	N.A.	N.A.	N.A.	N.A. GIGA JOULES
AUX. FOSSIL FUEL	2.156	5.313	N.A.	7.250 GIGA JOULES
ELECTRICAL SAVINGS	-0.018	0.000	N.A.	-0.674 GIGA JOULES
FCSSIL SAVINGS	0.535	0.251	N.A.	0.859 GIGA JOULES

SYSTEM PERFORMANCE FACTOR: 0.532

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REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978, SOLAR/0004-78/18

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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENERGY COLLECTION AND STORAGE SUBSYSTEM (ECSS)

SITE: WASHINGTON NATURAL GAS
REPORT PERIOD: DECEMBER,1978

SOLAR/1002-78/12

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	AMBIENT TEMP DEG-F	ENERGY TO LOADS MILLION BTU	AUX THERMAL TO ECSS MILLION BTU	ECSS OPERATING ENERGY MILLION BTU	ECSS ENERGY REJECTED MILLION BTU	ECSS SOLAR CONVERSION EFFICIENCY
1	0.018	43	0.003	N	0.014	N	0.176
2	0.266	43	0.002	O	0.013	O	0.007
3	0.031	47	0.010	T	0.015	T	0.343
4	0.136	43	0.002		0.014		0.016
5	0.516	40	0.041	A	0.026	A	0.079
6	0.720	35	0.003	P	0.030	P	0.004
7	0.500	34	0.074	P	0.025	P	0.148
8	0.141	38	-0.022	L	0.019	L	-0.157
9	0.045	42	-0.003	I	0.011	I	-0.059
10	0.028	43	-0.014	C	0.015	C	-0.493
11	*	*	*	A	*	A	*
12	*	*	*	B	*	B	*
13	0.731	41	0.018	L	0.026	L	0.024
14	0.130	45	-0.001	E	0.015	E	-0.007
15	0.133	41	-0.020		0.019		-0.147
16	0.091	41	-0.012		0.014		-0.126
17	0.137	44	-0.011		0.014		-0.077
18	0.246	39	-0.014		0.014		-0.057
19	0.097	37	-0.037		0.020		-0.381
20	0.029	42	-0.050		0.027		-1.732
21	0.013	42	-0.016		0.016		-1.223
22	0.022	43	-0.014		0.015		-0.633
23	0.001	46	-0.008		0.008		-7.596
24	0.455	44	0.000		0.007		0.000
25	0.626	36	0.026		0.031		0.042
26	0.527	36	0.097		0.021		0.184
27	0.717	35	0.094		0.021		0.131
28	0.807	25	0.134		0.029		0.166
29	0.770	21	0.138		0.032		0.179
30	0.236	19	*		0.031		*
31	0.781	18	0.020		0.040		0.025
SUM	9.568	-	0.489	N.A.	0.622	N.A.	-
AVG	0.309	38	0.016	N.A.	0.020	N.A.	0.051
NBS ID	Q001	N113			Q102		N111

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
COLLECTOR ARRAY PERFORMANCE

SITE: WASHINGTON NATURAL GAS
REPORT PERIOD: DECEMBER,1978

SOLAR/1002-78/12

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	OPERATIONAL INCIDENT ENERGY MILLION BTU	COLLECTED SOLAR ENERGY MILLION BTU	DAYTIME AMBIENT TEMP DEG F	COLLECTOR ARRAY EFFICIENCY
1	0.018	0.000	0.000	43	0.000
2	0.266	0.063	0.040	43	0.152
3	0.031	0.000	0.000	48	0.000
4	0.136	0.027	0.015	41	0.108
5	0.516	0.327	0.110	48	0.213
6	0.720	0.204	0.018	38	0.026
7	0.500	0.316	0.121	38	0.241
8	0.141	0.000	0.000	38	0.000
9	0.045	0.000	0.000	43	0.000
10	0.028	0.000	0.000	43	0.000
11	*	*	*	*	*
12	*	*	*	*	*
13	0.731	0.649	0.225	42	0.308
14	0.130	0.004	-0.001	47	-0.009
15	0.133	0.000	0.000	41	0.000
16	0.091	0.000	0.000	40	0.000
17	0.137	0.000	0.000	43	0.000
18	0.246	0.000	0.000	40	0.000
19	0.097	0.000	0.000	36	0.000
20	0.029	0.024	-0.007	*	-0.248
21	0.013	0.000	0.000	42	0.000
22	0.022	0.000	0.000	42	0.000
23	0.001	0.000	0.000	47	0.000
24	0.455	0.277	0.109	46	0.240
25	0.626	0.530	0.171	40	0.273
26	0.527	0.440	0.151	38	0.287
27	0.717	0.594	0.190	37	0.265
28	0.807	0.720	0.228	28	0.283
29	0.770	0.688	0.217	25	0.282
30	0.236	0.052	0.019	22	0.080
31	0.781	0.709	0.122	22	0.157
SUM	9.568	6.011	1.847	-	-
AVG	0.309	0.194	0.060	39	0.193
NBSID	Q001		Q100		N100

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
STORAGE PERFORMANCE

SITE: WASHINGTON NATURAL GAS
REPORT PERIOD: DECEMBER,1978

SOLAR/1002-78/12

DAY OF MONTH	ENERGY TO STORAGE MILLION BTU	ENERGY FROM STORAGE MILLION BTU	CHANGE IN STORED ENERGY MILLION BTU	STORAGE AVERAGE TEMP DEG F	STORAGE EFFICIENCY
1	0.000	0.000	-0.005	68	1.000
2	0.000	0.000	0.002	69	1.000
3	0.000	0.000	0.002	68	1.000
4	0.000	0.000	-0.007	67	1.000
5	0.031	0.013	0.012	70	0.807
6	0.000	-0.005	0.012	69	1.000
7	0.081	0.053	-0.016	70	0.456
8	0.000	-0.027	-0.011	66	1.000
9	0.000	-0.015	-0.003	67	1.000
10	0.000	-0.016	0.001	66	1.000
11	*	*	0.006	*	*
12	*	*	*	*	*
13	0.153	0.010	0.014	73	0.155
14	0.000	-0.004	-0.015	67	-49.625
15	-0.000	-0.027	0.003	67	754.156
16	0.000	-0.021	-0.001	67	1.000
17	0.000	-0.015	-0.007	67	1.000
18	0.000	-0.017	0.002	66	1.000
19	0.000	-0.038	0.008	66	1.000
20	0.000	-0.022	0.001	67	1.000
21	0.000	-0.018	-0.005	67	1.000
22	0.000	-0.020	-0.000	67	1.000
23	0.000	-0.010	-0.005	66	1.000
24	0.066	0.000	0.059	70	0.891
25	0.116	0.013	0.044	80	0.494
26	0.106	0.072	-0.025	80	0.444
27	0.130	0.070	0.007	81	0.594
28	0.144	0.090	-0.014	79	0.529
29	0.134	0.076	-0.022	76	0.402
30	0.000	-0.033	-0.044	66	1.000
31	0.052	-0.013	-0.006	68	-0.375
SUM	1.083	0.102	-0.017	-	-
AVG	0.035	0.003	-0.001	70	0.078
NBS ID	Q200	Q201	Q202		N108

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
HOT WATER SUBSYSTEM

SITE: WASHINGTON NATURAL GAS
REPORT PERIOD: DECEMBER,1978

SOLAR/1002-78/12

DAY OF MON.	HOT WATER LOAD MILLION BTU	SOLAR FR.OF LOAD PER CENT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	SUP. WAT. TEMP DEG F	HOT WAT. TEMP DEG F	HOT WATER USED GAL
1	0.061	23	0.003	0.000	0.058		0.097	-0.000	0.005	52	148	72
2	0.051	9	0.002	0.000	0.049		0.081	-0.000	0.003	50	159	56
3	0.065	14	0.010	0.000	0.055		0.091	-0.000	0.017	52	148	82
4	0.039	9	0.002	0.000	0.037		0.062	-0.000	0.004	52	147	49
5	0.020	9	0.002	0.001	0.017		0.029	-0.001	0.004	51	150	23
6	0.022	18	0.007	0.002	0.015		0.024	-0.002	0.012	52	150	25
7	0.030	28	0.012	0.001	0.018		0.030	-0.001	0.020	52	154	35
8	0.019	30	0.005	0.000	0.014		0.023	-0.000	0.009	51	147	22
9	0.095	19	0.013	0.000	0.082		0.137	-0.000	0.021	48	156	105
10	0.058	7	0.002	0.000	0.056		0.093	-0.000	0.004	48	162	64
11	*	*	*	*	*		*	*	*	*	*	*
12	*	*	*	*	*		*	*	*	*	*	*
13	0.012	8	0.004	0.001	0.009		0.014	-0.001	0.006	55	144	16
14	0.007	17	0.003	0.000	0.004		0.007	-0.000	0.005	54	138	8
15	0.030	21	0.008	0.000	0.023		0.038	-0.000	0.013	48	154	37
16	0.062	18	0.009	0.000	0.053		0.088	-0.000	0.015	48	152	71
17	0.066	10	0.004	0.000	0.062		0.103	-0.000	0.007	49	153	77
18	0.087	5	0.003	0.000	0.084		0.140	-0.000	0.005	47	159	96
19	0.051	3	0.001	0.000	0.050		0.083	-0.000	0.002	47	149	57
20	0.003	3	0.000	0.001	0.003		0.004	-0.001	0.000	47	148	3
21	0.021	7	0.003	0.000	0.018		0.031	-0.000	0.005	47	143	24
22	0.057	9	0.006	0.000	0.051		0.086	-0.000	0.010	49	150	67
23	0.036	7	0.002	0.000	0.034		0.056	-0.000	0.003	48	169	38
24	0.000	0	0.000	0.001	0.000		0.000	-0.001	0.000	48	172	0
25	0.045	19	0.013	0.001	0.032		0.053	-0.001	0.022	54	151	48
26	0.063	31	0.025	0.001	0.038		0.063	-0.001	0.042	54	156	68
27	0.077	32	0.024	0.001	0.053		0.089	-0.001	0.040	49	153	93
28	0.090	33	0.029	0.001	0.061		0.101	-0.001	0.048	46	154	97
29	0.132	35	0.049	0.001	0.084		0.139	-0.001	0.081	45	153	148
30	*	*	*	0.000	*		*	-0.000	*	*	*	*
31	0.082	40	0.033	0.002	0.049		0.082	-0.002	0.055	44	160	83
SUM	1.530	-	0.304	0.017	1.226	N.A.	2.043	-0.017	0.507	-	-	1746
AVG	0.049	20	0.010	0.001	0.040	N.A.	0.066	-0.001	0.016	50	153	56
NBS	Q302	N300	Q300	Q303	Q301	Q305	Q306	Q311	Q313	N305	N307	N308

NOT APPLICABLE

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SPACE HEATING SUBSYSTEM

SITE: WASHINGTON NATURAL GAS
REPORT PERIOD: DECEMBER,1978

SOLAR/1002-78/12

DAY OF MON.	SPACE HEATING LOAD MILLION BTU	SOLAR FR.OF LOAD PCT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	BLDG TEMP DEG. F	AMB TEMP DEG. F
1	0.085	0	0.000	0.015	0.085		0.142	0.000	0.000	71	42
2	0.076	0	0.000	0.011	0.076		0.126	0.000	0.000	70	43
3	0.097	0	0.000	0.016	0.097		0.162	0.000	0.000	72	47
4	0.081	0	0.000	0.014	0.081		0.135	0.000	0.000	71	43
5	0.129	30	0.038	0.020	0.091		0.151	0.000	0.064	71	40
6	0.052	-9	-0.005	0.010	0.057		0.095	0.000	-0.008	71	35
7	0.179	35	0.063	0.018	0.116		0.194	0.000	0.104	67	34
8	0.091	-30	-0.027	0.020	0.119		0.198	0.000	-0.046	71	38
9	0.057	-27	-0.015	0.012	0.073		0.121	0.000	-0.026	71	42
10	0.067	-24	-0.016	0.016	0.083		0.139	0.000	-0.027	70	43
11	*	*	*	*	*		*	*	*	*	*
12	*	*	*	*	*		*	*	*	*	*
13	0.099	14	0.014	0.015	0.085		0.142	0.000	0.023	72	41
14	0.073	-5	-0.004	0.014	0.076		0.127	0.000	-0.006	71	45
15	0.097	-28	-0.027	0.021	0.124		0.207	0.000	-0.046	71	41
16	0.063	-33	-0.021	0.015	0.084		0.140	0.000	-0.035	70	41
17	0.068	-22	-0.015	0.015	0.082		0.137	0.000	-0.025	71	44
18	0.071	-24	-0.017	0.015	0.086		0.147	0.000	-0.029	71	39
19	0.099	-39	-0.038	0.022	0.138		0.229	0.000	-0.064	70	37
20	0.052	-93	-0.051	0.030	0.102		0.171	0.000	-0.084	69	42
21	0.083	-22	-0.018	0.018	0.102		0.169	0.000	-0.031	70	42
22	0.080	-25	-0.020	0.017	0.100		0.166	0.000	-0.033	70	43
23	0.039	-26	-0.010	0.009	0.049		0.082	0.000	-0.017	68	46
24	0.000	0	0.000	0.000	0.000		0.000	0.000	0.000	62	44
25	0.168	8	0.013	0.022	0.155		0.258	0.000	0.022	72	36
26	0.146	49	0.072	0.012	0.074		0.123	0.000	0.120	72	36
27	0.143	49	0.070	0.011	0.073		0.121	0.000	0.117	70	35
28	0.220	47	0.104	0.019	0.116		0.193	0.000	0.174	71	25
29	0.223	40	0.089	0.022	0.133		0.222	0.000	0.149	71	21
30	0.177	-18	-0.033	0.034	0.210		0.349	0.000	-0.055	70	19
31	0.146	-9	-0.013	0.026	0.159		0.265	0.000	-0.022	71	18
SUM	3.164	-	0.142	0.522	3.021	N.A.	5.036	0.000	0.237	-	-
AVG	0.102	5	0.005	0.017	0.097	N.A.	0.162	0.000	0.008	70	38
NBS	Q402	N400	Q400	Q403	Q401		Q410	Q415	Q417	N406	N113

NOT APPLICABLE

* DENOTES UNAVAILABLE DATA.
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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SPACE COOLING SUBSYSTEM

SITE: WASHINGTON NATURAL GAS
REPORT PERIOD: DECEMBER,1978

SOLAR/1002-78/12

DAY OF MON.	SPACE COOLING LOAD MILLION BTU	SOLAR FR. OF LOAD PCT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	BLDG DRY BULB TEMP F	AMB TEMP DEG F
1	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	71	43
2										70	43
3										72	47
4										71	43
5										71	40
6										71	35
7										67	34
8										71	38
9										71	42
10										70	43
11										*	*
12										*	*
13										72	41
14										71	45
15										71	41
16										70	41
17										71	44
18										71	39
19										70	37
20										69	42
21										70	42
22										70	43
23										68	46
24										62	44
25										72	36
26										72	36
27										70	35
28										71	25
29										71	21
30										70	19
31										71	18
SUM	N.A.	-	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	-	-
AVG	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	70	38
NBS	Q502	N500	Q500	Q503	Q501		Q508	Q512	Q514	N406	N113

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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENVIRONMENTAL SUMMARY

SITE: WASHINGTON NATURAL GAS
REPORT PERIOD: DECEMBER,1978

SOLAR/1002-78/14

DAY OF MONTH	TOTAL INSOLATION BTU/SQ.FT	DIFFUSE INSOLATION BTU/SQ.FT	AMBIENT TEMPERATURE DEG F	DAYTIME AMBIENT TEMP DEG F	RELATIVE HUMIDITY PERCENT	WIND DIRECTION DEGREES	WIND SPEED M.P.H.
1	30	N	43	43	N	N	N
2	450	O	43	43	O	O	O
3	52	T	47	48	T	T	T
4	230		43	41			
5	874	A	40	48	A	A	A
6	1219	P	35	38	P	P	P
7	847	P	34	38	P	P	P
8	239	L	38	38	L	L	L
9	76	I	42	43	I	I	I
10	48	C	43	43	C	C	C
11	*	A	*	*	A	A	A
12	*	B	*	*	B	B	B
13	1236	L	41	42	L	L	L
14	219	E	45	47	E	E	E
15	225		41	41			
16	154		41	40			
17	232		44	43			
18	417		39	40			
19	164		37	36			
20	49		42	*			
21	22		42	42			
22	37		43	42			
23	2		46	47			
24	770		44	46			
25	1060		36	40			
26	892		36	38			
27	1214		35	37			
28	1365		25	28			
29	1303		21	25			
30	400		19	22			
31	1321		18	22			
SUM	16190	N.A.	-	-	-	-	-
AVG	522	N.A.	38	39	N.A.	N.A.	N.A.
NBS ID	Q001		N113			N115	N114

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